AEI

Electrical Distribution

THE NEWS MAGAZINE OF THE CABLE AND CONSTRUCTION (CABLES & LINES) DIVISIONS OF ASSOCIATED ELECTRICAL INDUSTRIES LTD

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EDITORIAL

DUNGENESS, FROM BEING a windy waste, of interest chiefly to naturalists, is noteworthy today on several counts of a different nature.

Dungeness nuclear power station is rising in the area, and the shore was recently the scene of the cross-Channel cable-laying, described in this issue.

Evidence of another development can also be seen at the Corporation of Trinity House experimental establishment, Dungeness, where there stands a strange-looking structure of glass and brick containing a block of 400 solar cells. It has been built to investigate the use of such cells to power navigational lights on buoys—a development which, it is hoped, will be practicable in a further two years' time, when various problems have been overcome.

In any discussion on power derived from solar cells the phrase "unfavourable English climate" is heard. Similar words were used when the "solar house" was erected in Phoenix, Arizona, some years ago. Efficiency in control and storage of the sun's energy through solar cells have a long way to go, but forward-looking people do not discount the possibility, even in temperate climates, of harnessing solar energy to the needs of everyday life.

AEI

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OUR COVER PICTURE

The *Dame Caroline Haslett* lies off Dungeness as the cross-Channel power cables are winched ashore attached to floats. The story of the operation is to be found on page 134 of this issue.

News in brief...

Cable Division Appointments

THE REORGANIZATION OF the A.E.I. Cable Division has resulted in the appointment of **Mr J. S. A. Bunting,** formerly joint Divisional general manager, to the Board of Associated Electrical Industries (Woolwich) Ltd.

Chief Executive appointments are now held by:

Mr E. J. Vidler—Divisional general manager and director of A.E.I. Divisional Management Company.

Mr F. V. Vassiere—Divisional commercial manager.

Mr V. L. J. Plascott—Divisional manufacturing manager.

Mr W. G. Hawley—Divisional chief engineer.

A.E.I. Cable Division is now organized into four Product Groups: Power Cable Group, of which **Mr K. S. Estlin** is sales manager; Super Tension Cable Group, sales manager **Mr R. G. Holland;** Rubber and Plastic Cables and Wires Group, sales manager **Mr D. Beavan;** and the Distribution Equipment and Accessories Group, sales manager **Mr H. Hubbard.**

Copper-bearing Steels

A NEW BOOKLET, *Copper-bearing Steels for Structural Purposes*, has been published by the Copper Development Association. It is available upon request from the Association at 55 South Audley Street, London, W.1.

The booklet has been produced to describe the advantages of copper-bearing steels in a handy form. It examines briefly, with charted data, the corrosion properties of copper steels compared with normal mild steel and gives a table for exposure results on painted steels over an eight-year period. The effect of copper additions on properties of steel other than corrosion resistance is also discussed.

The booklet mentions the high-strength low-alloy steels—copper-bearing steels with the addition of nickel or chromium, the type known as Cor-Ten used on the experimental Project EHV in the U.S.A. (ELECTRICAL DISTRIBUTION, May 1961 issue, p. 98). This type of steel, developed during the war, is now manufactured by some of the principal steel-makers in Great Britain and is available in most forms. Although these steels are more costly than the straight copper-bearing steels, it has been found that their increased strength allows a reduction in section thickness which largely counteracts their extra cost.

Copper-bearing steel is recognized by B.S. 15 (structural steel), B.S. 548 (high-tensile structural steel), and B.S. 968 (fusion-welding quality high-tensile structural steel).

A list of supplementary references is also given.

Submarine Cables Limited

THE DIRECTORS OF Submarine Cables Limited (owned jointly by A.E.I. and B.I.C.C.) announce the appointments of **Mr G. H. Foot,** B.SC.(ENG.), A.C.G.I., A.M.I.E.E., A.M.AM.I.E.E., as director and chief engineer and of **Mr S. J. Wilson** as works director.

Mr Foot joined Submarine Cables Limited in 1958 from A.E.I. Woolwich and in 1959 became manager of the Repeater Division. Mr Wilson, who started his career with W. T. Henley's Telegraph Works in 1922, has been joint manufacturing manager of the A.E.I. Cable Division since January 1960.

New Supergrid Substation at Kincardine

132KV A.E.I. CABLES are to be installed at Kincardine Generating Station under a £40 000 contract recently awarded to the A.E.I. Construction (Cables and Lines) Division by the South of Scotland Electricity Board.

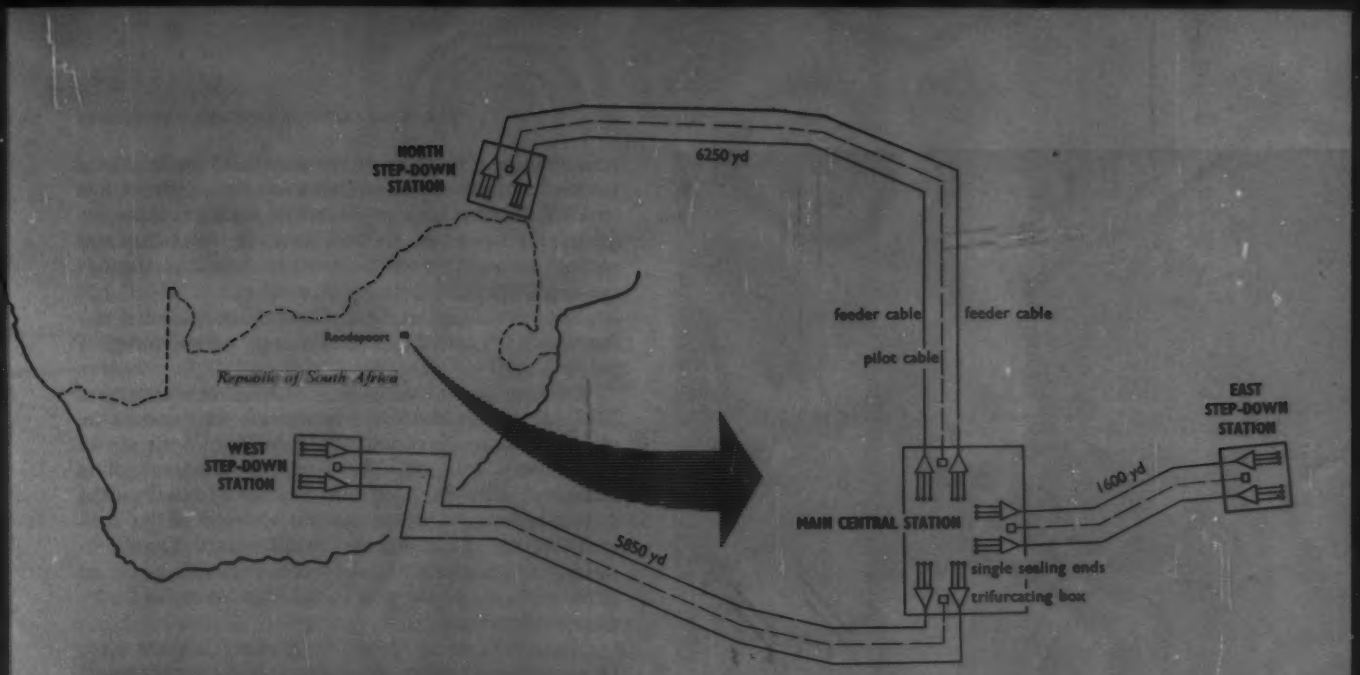
The contract covers the supply and installation of two 132kV circuits of six 0·75sq.in. single-core oil-filled cables between the 240MVA 275/132kV supergrid interbus transformers and the adjacent 132kV substation, and one circuit of three 0·82sq.in. 132kV single-core oil-filled cables between the 132kV substation and the termination of a 275kV overhead line, now in course of construction for operation initially at 132kV, linking with the North of Scotland Hydro-Electric Board's system in the vicinity of Abernethy.

Included in the contract are the supply and installation of approximately 7 400yd of l-v power, multicore, and telephone auxiliary cables associated with the new 275kV substation.

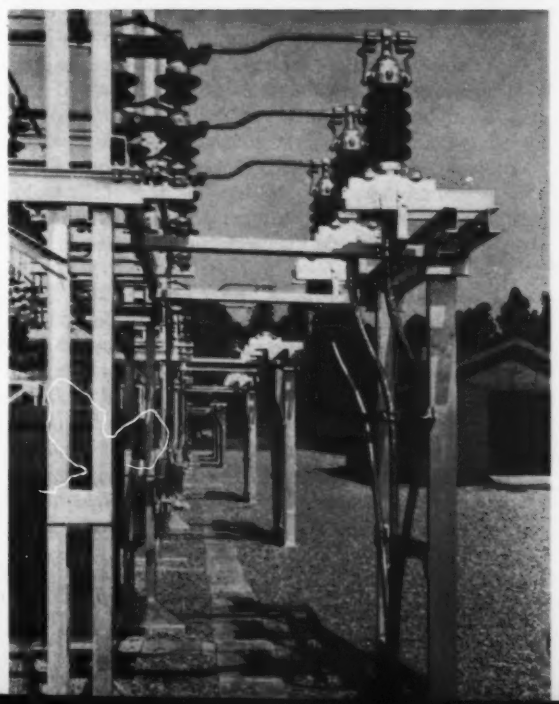
Power Reinforcement at Swindon

IN CONNECTION WITH the reinforcement of supplies at Stratton, near Swindon, A.E.I. Construction (Cables and Lines) Division engineers are to carry out cabling work for the Southern Electricity Board in the Newbury Sub-Area.

The cabling is covered by two separate contracts with a combined value of £37 000. Two new 33kV 0·25sq.in. 3-core oil-filled feeders will be installed from Stratton Grid substation along separate routes to the Board's Park North substation for supply to the London County Council overspill housing development at Swindon, and to the substation serving the Pressed Steel Company Limited. Total route length of the two cables is some 8 000yd.



The Roodepoort-Maraisburg scheme



FIRST DSO CABLES IN SOUTH AFRICA

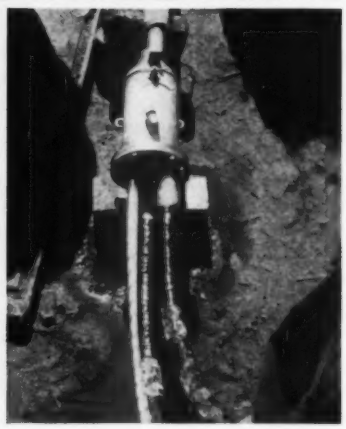
FIVE YEARS AGO the town council of Roodepoort-Maraisburg in the Republic of South Africa decided to modernize its electricity supply system in line with expansion taking place in the area. Through a contract awarded to Henley-Simplex on behalf of Associated Electrical Industries, engineers of the A.E.I. Construction (Cables and Lines) Division have been installing the first 33kV ductless type oil-filled cables to be used in the Republic. The work is now complete, after two years of planning and construction.

Replanning

When the new supply system comes into operation, it will replace the previous system whereby the town council was served by two separate points of supply at 6·6kV by the Electricity Supply Commission. The new

Top illustration shows cable-laying in progress on the northern section.

Terminations of oil-filled cables at Main Central Station.



▲ **These three illustrations show the sequence of operations in fitting the flanged, reinforced lead tube tails over the cores. Bottom right shows two tails fitted with the third core stripped.**

scheme takes advantage of the growth of the load to a point which necessitates an increase in the supply voltage to 33kV to introduce a single central point of supply, retaining the two existing 6·6kV points in the eastern and western areas of the municipality as stepdown stations and erecting a third in the northern area.

The central station, Main Central Station, has a rating of 60MVA, and the stepdown stations have ratings of 10MVA each.

By arrangement with the Commission a supply at 33kV will be provided for the council via 40kV lines to the central station, where initially three 15MVA stepdown transformers have been installed, providing a loading facility of 30MVA, with one unit as a standby. The station is designed to accommodate a total of five such transformers, including the standby unit. The Commission's arrangements have been designed, as far as practicable, for conversion to 80kV to allow for future growth of demand.

From the central station, supplies at 33kV are taken by underground cables to the two existing supply points in the eastern and western areas of the town council's municipality, where it is stepped down to 6·6kV. A third stepdown station has been erected in the northern area of the municipality and this also receives power by means of underground cables at 33kV. The 6·6kV networks between these three stepdown stations will be integrated for standby purposes but will not normally be interconnected.

Initially, each stepdown station is supplied by a pair of 33kV feeders, and future development allows for an additional 10MVA stepdown station to be added to each circuit, so that ultimately each of the three pairs of feeders will comprise a ring circuit supplying two 10MVA stepdown stations. In addition, two spare bays have been provided at Main Central Station for an additional circuit to supply a further two 10MVA stepdown stations.

The installations at the northern and eastern substations are of the outdoor, single bus-bar type, comprising two incoming bays to supply common bus-bars, and two transformer-feeder bays. The bays are equipped with isolators and circuit-breakers in the conventional manner, all bays being rated at 400A.

The western site uses the existing 40kV building, which has been vacated by the Electricity Supply Commission, for an indoor installation. The size of the building permits the use of almost identical switchgear arrangements to those at the outdoor sites.

Cable Installation

From the Main Central Substation three pairs of parallel feeders with a common pilot radiate to the stepdown stations. The route lengths to the west, north, and east stations are 5 850yd, 6 250yd, and 1 600yd respectively.

The "ductless" type cables installed for the municipality at Roodepoort-Maraisburg hold the oil in the spaces between the insulated and screened cores and the reinforced lead alloy sheath—a recognized economic

construction. The 33kV feeders installed on this contract had 0·2sq.in. shaped conductors, paper-insulated and screened, laid up and lead alloy sheathed. The sheath was taped with compounded cotton tape, followed by tin-bronze tape reinforcement, anti-corrosion serving (QR2QH2—p.v.c./2 rubber/p.v.c./2 hessian tapes) galvanized steel wire armouring and, finally, two compounded hessian tapes over the armouring. The pilot was a 16-core 7/·029in. PILCSWA and served cable for supervisory and protective functions.

The oil-filled cables forming each circuit were laid direct in the ground (with their accompanying pilot) in a common trench. Drum lengths of up to 700yd were used, jointed by straight-through open joints and oil/oil stop joints, the latter being placed at predetermined positions on the profile of the route where the hydraulic head had to be limited to the maximum working pressure.

Adjacent to terminations in the central station and the stepdown stations, trifurcating boxes were used on each cable to separate the three cores prior to terminating on sealing ends. The stripped cores were individually resheathed on site with reinforced and anti-corrosion served lead tubes. After fitting the tubes, a high degree of vacuum was applied to the resheathed cable tails which were then fully re-impregnated with cable oil. The separated cores thus became three individual single-core oil-filled cables having conductors continuous with the 3-core cable. These single tails were terminated in outdoor type oil-filled sealing ends mounted on gantries.

Cable Protection

Pressure tanks located at selected oil-feeding points maintain static oil pressures and take care of transient pressures. At these points visual pressure gauges with alarm contacts are mounted in cabinets in the pressure tank cubicles to supervise the oil pressure over all the oil sections. The gauge contacts for both feeders on each route are connected through three cores of the pilot cable to a low-oil-pressure alarm panel housed in Main Central Station. This panel is relay operated and gives immediate visual and audible warning of low oil pressure in any part of the system. The particular oil section in which an alarm has been initiated can readily be located from Main Central Station by means of a built-in slide-wire bridge calibrated for the individual oil sections in the system.

In addition to the low-oil-pressure arrangements just described, outgoing feeders from Main Central Station are equipped with translay, overcurrent, and earth-fault protection. At the stepdown stations similar protection is provided, except that the overcurrent and earth-fault protection is directional.

This new 33kV supply system for Roodepoort-Maraisburg involved the supply and installation of 15½ miles of oil-filled cable and about eight miles of pilot cable. The value of the contract approached £100 000. Cables were manufactured in the United Kingdom, together with all the necessary joints and termination equipment. A.E.I. Construction Division also provided supervisory staff and special mobile oil treatment and pumping plant from England. All work was accomplished to schedule.

Jointing of the cables was carried out by South African cable jointers, specially trained in England.

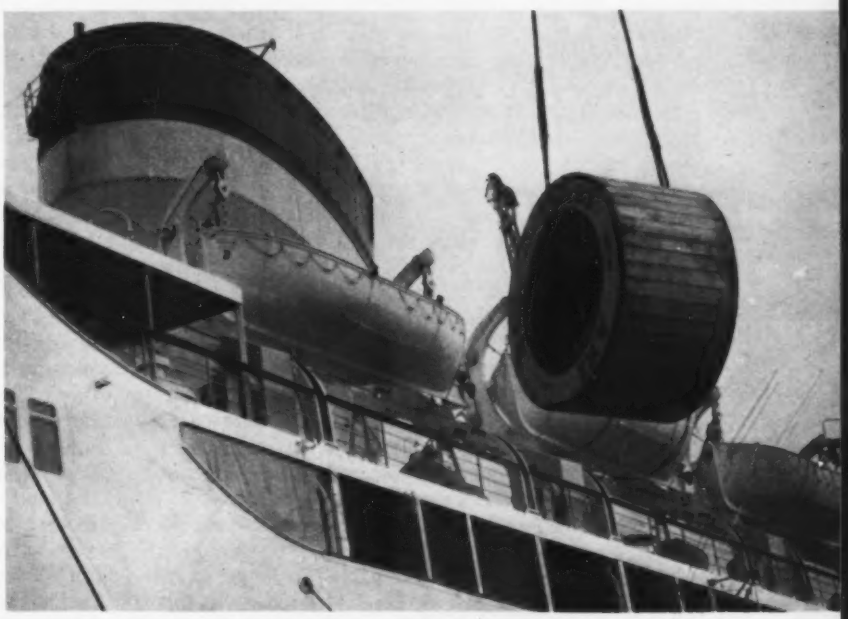
The entire Cable Construction Department of Henley-Simplex has been transferred to Siemens Edison Swan (Pty) Ltd (an A.E.I. Company) and its personnel will undertake servicing and maintenance of the works.

CABLES FOR BUENOS AIRES

A drum of A.E.I. cable, one of several large consignments, being shipped for Buenos Aires power station at the Royal Victoria Dock in the Port of London.

A.E.I. cables will be installed throughout the new Buenos Aires station, which is now being constructed. More than 250 000yd of 13·8kV and lower-voltage cables will be used and their installation will be supervised by A.E.I. Construction Division engineers.

The power station will be A.E.I. equipped and six of the 132kV outdoor substations of the associated Buenos Aires interconnection scheme are to have A.E.I. switchgear and transformer equipment.



Sir John Pickles delivering the presidential address.

EASTBOURNE

B.E.P.C. 1961

"EVERYTHING POINTS TO the conclusion that the electrical industry seems poised for a further period of continued expansion on a very substantial scale," said Sir John Pickles in his presidential address to the thirteenth British Electrical Power Convention.

He was speaking to a packed hall which had been welcomed by the Mayor of Eastbourne, while high winds and rain made the outside scene anything but welcome to the delegates.

Sir John placed the emphasis of his address on the future picture which faced the supply and manufacturing industries. We were, he said, in a period when the all-electric home, in the fullest sense of the word, was with us. The Clean Air Act alone, apart from its immediate impact on the design of all new buildings, should result, in the next ten to fifteen years, in at least 6 million existing dwellings and more than 1 million commercial premises being changed from burning raw coal to the smokeless fuels—prepared coal, coke, gas, oil, and electricity.

There seemed no reason to doubt a doubling of consumption by 1970. "But," he said, "can the consumption go on doubling every ten years? Are we in danger of regarding this as an immutable law? To continue at this rate for the next forty years would mean, even allowing for greatly improved load factor, that our present installed plant of some 30 000MW would rise to over 400 000MW; a prospect which our manufacturers would no doubt relish, but a formidable prospect by any standard." Trying hard to keep one's feet on the ground it did not, however, seem impracticable that the 1970 consumption would be doubled again, possibly by 1980, or by 1985 at the latest.

This implied that our present installed plant would have to increase to a figure approaching 60 000MW by 1970, and to more than 100 000MW by 1980–5. The 1 000MW set may have made its début and a 750kV transmission system seemed not unlikely.

Distribution will have necessitated greatly extended high-voltage systems with transformers for every twenty houses or so. The installation contractor could view the future with great confidence. There must be a development around the corner, Sir John thought, which would bring supervisory control of consumers' installations back into its own—a boon in the control of off-peak load.

Developments in the later period 1980–2000 were not easy to predict. Between 150 000–200 000MW of plant would possibly be required, and there was the vital question as to what fuels would then be available. Fossil fuels were a wasting asset with a finite life and their cost would increase as they became scarcer. Attention is at present focused on direct conversion from heat to electricity without the intervention of the steam cycle—the processes of thermionic, thermo-electric, and magneto-hydrodynamic generation, of which the last was the more immediately promising.

"The picture I have presented," concluded Sir John, "is of an industry throbbing with vitality; an industry with an assured and seemingly insatiable demand for its product, and one in which by technical advance the trend of costs relative to competitive fuels is decreasing, thereby assisting productivity and the country's capacity to compete in exports."

The Chinese Pavilion

On a site behind the Winter Gardens at Eastbourne, a large marquee was erected by Associated Electrical Industries Ltd. Cocktails, morning coffee, and afternoon tea were served and Convention delegates and their wives and friends were given an open invitation to this reception centre whenever they wished to relax.

The interior of the marquee was arranged as a

Chinese garden and the "Chinese Pavilion" became a popular rendezvous.

A cocktail party, which the Mayor and Mayoress of Eastbourne attended, launched the Pavilion on the opening day of the Convention and thereafter it was a successful feature of the Eastbourne scene.

The Pavilion's décor included a pool, waterfall, and goldfish, and a "willow-pattern" bridge; Chinese lanterns and Chinese-styled architectural adornments with oriental flowers and plants. A banner in Chinese read: "A.E.I. welcomes its illustrious guests." In keeping with the décor theme, a Chinese girl receptionist was in attendance and there were Chinese cocktails and cocktail savouries for the delectation of guests.

At night the path to the Pavilion was floodlit and marked by A.E.I. "Cathay" lanterns.

Other events

The *Luncheon of the Electrical Association for Women* is a feature of the Convention. This year, Mrs Mark Fraser, M.B.E., chairman of the E.A.W., proposed the toast to the Borough of Eastbourne, and the Mayor, in his reply, showed his awareness of the Association's work and its local branch.

The toast to the Convention theme, "Electricity in the Prosperity and Welfare of the Nation", was proposed by Miss Mary George, M.B.E., director, E.A.W., who spoke of the way the Association helped the intelligent woman shopper and the saleswoman.

Sir John Pickles, president of the Convention, replied to the toast and read a telegram from the Queen. Lady Kilmuir, D.B.E., president of the E.A.W., proposed a vote of thanks.

At the annual Convention dinner the toast of the B.E.P.C. was given by the Rt Hon. J. S. Maclay, M.P., Secretary of State for Scotland. He spoke of the advances made possible by electricity in Scotland and, illustrating the fact that old habits die hard, instanced the case of the lady of a highland croft whose phenomenally low consumption of electricity was due to the fact that she merely switched on the electric light for long enough to light the taper for the oil lamp! Sir John Pickles replied.

The toast of "Our Guests and Ladies" was proposed by the Rt Hon. the Viscount Chandos, D.S.O., M.C. (A.E.I.'s chairman), in a witty speech. The response by His Excellency the Hon. George A. Drew, Q.C., High Commissioner for Canada, emphasized the trade links which bind Britain and the Commonwealth.

The *Electrical Forum* saw four speakers facing a full house. They were Mr F. H. S. Brown, deputy chairman of the C.E.G.B., Mr A. A. Fulton, general manager of the North of Scotland Hydro-Electric Board, Sir Robertson King, chairman of the Electricity Council, and Mr S. Z. de Ferranti, managing director of Ferranti Ltd.

Concluding function of the Convention was the annual general meeting at which Sir William McFadzean was invested as president for 1961–2 and was elected vice-president.

▲

Top: **at the E.A.W. Lunch. From left, Lady McFadzean, Mrs R. S. Edwards, Mr F. H. Busby, Lady Eccles, Mr C. T. Melling, Lady Hinton, Lord Citrine, Lady Pickles, Sir Robertson King.**

Centre: **Mr G. F. Peirson (M.E.B.), Dr H. G. Taylor (E.R.A.), Mr R. W. Flux (Messrs Bruce Peebles), Messrs K. S. Estlin and D. B. Beavan (A.E.I.), with Mrs Peirson, Mrs Flux, and Mrs Taylor.**

Bottom: **Mr R. G. Widgery (S.E.E.B.), Mrs Widgery, Mr W. G. D. Gregg (A.S.E.E.), Messrs R. Hyde and R. V. Banks (A.E.I.).**

Sir Christopher Hinton

Mr R. R. Brown

Dr A. E. Grauer

Mr S. F. Steward

Four Convention speakers in the course of presenting their papers, from which abstracts are given, beginning on the opposite page.

The interior of A.E.I.'s marquee with Chinese garden décor. Below are photographs of Convention personalities taking their ease in the pavilion.

Mr A. H. Kenyon (E.M.E.B.), Mrs Kenyon, Mrs N. F. Marsh, Mr J. F. Stanier (E.M.E.B.), and Mrs J. A. McKerrell.

Mr K. S. Estlin (A.E.I.), Sir Christopher Hinton, and Mrs Estlin.

Dr and Mrs J. N. Aldington (*right*) greet Mr H. R. Scholfield (C.E.G.B. chief transmission project engineer) and Mrs Scholfield at the A.E.I. cocktail party.

Mr and Mrs S. E. Goodall (*left front*) behind them are Mr Ian F. Young (State of Guernsey E.B.) and Mr Young; and (*right*) Mrs H. S. Pockock and Mr H. S. Pockock (*Electrical Review*).

Abstracts from the Convention Papers

The British Electricity Transmission System

by SIR CHRISTOPHER HINTON, K.B.E., F.R.S.

In 1924 there were 368 a.c. supply systems in Great Britain and 191 d.c. supply systems. There were 494 generating stations of which only thirteen exceeded 50MW capacity.

In 1925 a committee was appointed to investigate the national problem of the supply of electrical energy; its recommendations, with certain modifications, were given effect in the Electricity (Supply) Act, 1926.

As a result, the 132kV grid came into being, based on operation in large self-contained areas. About 3 000 route miles of 132kV lines were constructed (in addition to 1 000 route miles operated at 66kV and lower voltages) and tied to the systems at 273 switching and transforming stations, having a total transformer capacity of about 8 100 000kVA.

Although interconnection between areas was intended only for dealing with line outages, it was in fact carried out experimentally by the control engineers in London and from the beginning of the war the grid was operated as a single unit.

The next step in supply development was the superimposition of the 275kV grid. The necessity for higher-voltage transmission had soon become evident and, although a 380kV system had been introduced in Sweden, it was decided not to adopt this voltage for the new system to be used in Britain owing to the shortage of time available for solving the insulation problems attendant upon the use of such a high voltage in our atmospheric conditions. It was decided to use the I.E.C. standard voltage of 275kV nominal, 300kV maximum. However, clearances on the heavy duty 275kV towers were to allow for possible uprating in the future to 380kV.

Future pattern of the transmission system

The maximum demand on the Board's system so far is 24 449MW on 13 December 1960. The trend of past years shows that this demand may be trebled in fifteen to twenty years' time. The general level of bulk power movement envisaged is in the region of 4 000MW over distances of 50–100 miles, but transfers as high as 8 000MW from the central coalfields towards the South Midlands, and a throughput of 6 000MW to the London area, a distance of 100–140 miles, are likely to be required. Concentration of as much coal-fired generating plant as possible on the Midlands and Yorkshire coalfields will mean that movement of fuels over long distances by rail will virtually cease and that sea-borne supplies will be reduced to roughly half their present value.

Considerable thought has been given to the best means of dealing with demands of the order of 70 000MW expected by the mid-1970s. Can a single national grid be continued and enlarged to carry this load, or will it be necessary to break it down into areas with more localized siting of generating plant? Would the problem best be met by breaking down into area grids heavily interconnected by asynchronous links?

Careful study of this complicated problem led to the decision to develop a 420kV system with a nominal voltage of 5% less than this: at this voltage the existing 275kV heavy duty lines can be converted for use at 400kV. Cost per mile for our transmission distances and the cost of terminal equipment led to the rejection of 500kV as a working voltage.

But 1975 is not a distant date and in adopting 400kV as its transmission voltage the Generating Board is making the assumption that a voltage of 700kV will be practicable by that date. Research to ensure this is being put in hand.

Past and present imperfections in the field of transmission

In spite of capital restrictions, expenditure on new transmission lines rose from £4½ million in 1948–9 to over £35 million in 1959–60; but even so it was never sufficient to keep up with requirements. Indeed, we now envisage a further doubling of the present expenditure on transmission in the next four or five years.

Prediction of the long-term trend in bulk demand is relatively simple on an area or a national scale, but it is more difficult to forecast local demands in size, time, and place. As a result, it has not been easy for the Area Boards to look much beyond the short term nor, from the point of view of their own engineering development, has this been necessary: the Generating Board, on the other hand, must look five years ahead from the inception of a major transmission scheme to its commissioning. A good deal of improvisation has resulted, which may not only be technically uneconomical but may also cause unnecessary offence against visual amenity.

Arising from this, the broad demarcation line for Area Board responsibility for equipment of 33kV (and some 66kV) or lower voltages could be due for revision to 275kV, as 132kV occupies the same position today in relation to distribution as 66kV did when the present arrangement was introduced.

Not all past inadequacies of the transmission system have arisen from the problem in forecasting local demands. Two other major factors have been: the difficulties of getting consents and wayleaves, and delays in construction.

The amenity problem has straight away to deal with the fact that about 40% of the area of England and Wales is subject to restriction of some sort or another on grounds of amenity.

A transmission network of the present strength is an essential part of our system. The country cannot afford to underground such a network, yet I do not believe that the public will tolerate indefinite extension of the present system.

Our ultimate concern must be the delivered cost of electricity to the consumer and this is most likely to be kept down if the pressure of conservationists on the *transmission* system is relieved by reasonable concession to them in relation to the *distribution* system.

Our past sins against amenity are still with us, but routing of lines is receiving considerable attention today. The problem of visual amenity of switching stations has not been satisfactorily solved and it may be here that, in spite of their costs, underground cables may be justified to avoid a surrounding jungle of towers.

The problem of visual amenity consequent upon expansion of the transmission system is the greatest problem which faces the industry and failure to solve it could shatter the whole foundation of greatness laid down with wisdom in the first half of this century.

Some Aspects of Efficiency and Economy in Distribution

by R. R. B. BROWN, B.A., B.SC.

Area Board investment in fixed assets at 31 March 1960 stood at £1 174 million and brought to the Area Boards a net revenue, after allowing for the bulk supplies of energy at grid points, of £156 million. The assets are almost entirely represented by engineering works (92·1% in 1959–60).

There is still a backlog of reinforcement work necessary to correct voltage and to avoid overloading of plant and, given the availability of capital, expenditure on standardization will undoubtedly rise considerably over the next five years.

Depreciation, interest, and financing expenses represent 40% of the total costs of Area Boards, excluding purchases of electricity in bulk, and thus capital economies coupled with the full use of distribution facilities are of great importance provided that a well-loaded system is in operation.

Capital economies in distribution

Reliability of supply and economy must strike the best possible balance. In overhead-line practice developments consistent with this rule have been the derivation of the unearthed B.S. 1320 11kV line design from the original bonded and earthed pole lines to the Electricity Commissioners' Regulations and its development for heavier conductors and voltages. Pole diameters have also been reduced as regulations have been revised. Aluminium conductors and S.C.A. conductors have proved cheaper than copper conductors. The individual h-v fusing of pole transformers has been generally superseded by group fusing at the point of tapping from the main line only. Occasionally, appreciable economies have resulted where l-v conductors have been run on the same poles as h-v conductors and economies are also resulting from various types of joint-user construction with Post Office lines. Railway crossing conditions have been eased, and single-wire earth return construction is under investigation for conditions in this country.

In the cable field the very extensive use of oil- and gas-filled cables is both reducing the cost and increasing the reliability of supply networks. A considerable amount of l-v and h-v aluminium cable is being used; a major expansion of the use of aluminium cored and sheathed cable is dependent in the long run on long-term assurance of freedom from corrosion problems; easy and efficient jointing techniques; the maintenance of an economic price differential between copper and aluminium; and a high price of lead. Solid segmental aluminium conductor type cables may have many applications resulting in a reduction of first cost. New types of p.v.c. cables are being tried out in conjunction with new jointing techniques, and protective multiple earthing could, provided that the Ministry of Power's conditions are modified, result in a saving to the national economy.

The use of cold-rolled grain-orientated steel, economies in design of transformers, and the two-unit type of installation at step-down substations have resulted in cost savings.

Efforts to reduce switchgear costs have resulted in the use of 33kV airbreak switches to control transformers; 33kV fault-throwing switches on transformer feeders; and the use of teed transformer feeders with transformers controlled by either indoor non-automatic oil switches or outdoor airbreak switches with interrupter heads.

Growth of load on a substation necessitating an increase in firm capacity often brings expense in changing switchgear on the secondary side because of inadequate rupturing capacity. In such a situation the immediate switching-in of a spare transformer, in the event of a fault on one of the transformers on load, is a method which may have a wider application in avoiding expenditure on switchgear of higher rupturing capacity.

The fullest use of plant and equipment

For measuring performance in the fullest use of plant and equipment the industry has a convenient yardstick in the load factor, which has shown a fairly steady improvement over the last twelve years to a figure of 47·4%.

From a study of load curves it can be seen that the load factor over the 24 hours of a working day is about 70%; over the 168 hours of a week it falls to about 63% owing chiefly to the week-end drop in industrial requirements; over a month it is about 60%. The major cause of reduction in the annual load factor is the seasonal variation in demand.

Thus the main ways of securing further improvement in the annual load factor are to build up night-time and week-end loads, to extend summer use of electricity, and to level off the most acute peaks.

Tariff incentives are aimed at consumers with this end in view, but climate, reluctance to change living habits, and rigidities in the pattern of industrial activity are limiting factors which make any spectacular improvement unlikely.

The development of new and improved applications and equipment involves load research and the investigation of market potentiality, which includes discovering user attitudes to indicate the direction in which to develop apparatus to give maximum benefit in improved load factor. Costs of off-peak control of small supplies have been compared for methods using individual time switches, pilot-wire operation of voltage-sensitive contactors in the consumer's premises, d.c. bias, and audio-frequency injection. The pilot-wire method promises to prove economical for new l-v networks.

Other research and development work is going on in the fields of thermal storage heating (floor and road warming and storage block heating), industrial heating, steel melting (electric arc furnaces are now being developed with a capacity of 110 ingot tons and a rating of 40 000kVA, and load factor can be improved by staggering the working cycles of two or more furnaces), and various applications in agriculture and horticulture, such as irrigation, crop-drying, hydro-cooling, and light irradiation.

The Electrical Power Industry in Canada

by Dr A. E. GRAUER, B.A., PH.D., LL.D.

Canada, despite her relatively small population of about 18 million, is one of the world's largest producers and consumers of electric power. In terms of output, she stands in the top group, behind the United States and the Soviet Union, but roughly on a par with the United Kingdom. On a *per capita* basis, Canada is second only to Norway.

During the development of the country, water resources were readily available and various large power sites existed near early centres of population. Hydro costs in central Canada were so much lower than thermal power from coal in the eastern United States that they formed a continuing magnet for power-intensive industries.

The combination of an abundance of low-cost electricity,

relatively high wage rates, and an economy unusually dependent upon external trade has resulted in a high degree of mechanization of Canadian industry.

For some years now, about one out of every fifteen dollars spent on the construction of new plant and equipment in Canada has gone toward the generation, transmission, and distribution of electricity. Also, for every dollar spent by the electric power utilities, two dollars have gone into the equipment and modernization of new and existing homes, shops, and manufacturing plants. It might, therefore, be said that around 20% of all capital investment in Canada is related to the production and consumption of electricity as such.

Present structure of the Canadian electrical industry

The pattern of population growth in a series of relatively densely settled areas, strung mostly along the southern border of Canada, has meant that the transmission and distribution of electric power have not been a matter of covering the great distances suggested by the length and breadth of the country.

The electric power industry, therefore, has been, and remains, predominantly provincial in character and its organization varies a good deal from one province to another, particularly with regard to the degree of public and private ownership. The proportional consumption of industrial power is relatively higher in Canada than in the U.S.A. or the United Kingdom, being a little over 70% of total consumption in Canada and under 55% in each of the two other countries. Canadians, nevertheless, use more power in their homes than do the people in the U.S.A. and the United Kingdom. Annual consumptions per residential customer average: Canada, 4 300kWh; U.S.A., 3 700kWh; United Kingdom, 2 000kWh.

Social and competitive factors should tend to approximate the Canadian figure towards the North American average. The simple block rate method of charging for electricity is in widespread use in Canada and this doubtless aids our high levels of consumption.

Future requirements for electricity in Canada and financing growth

Canada's power needs are growing at around 5% per year. Add somewhat more than 2% per year due to population growth and Canada's current rate of electrical growth is about 7% a year. A recent survey of Canada's peak loads and capabilities suggests that, by 1965, generating capacity will rise by more than 25% and be close to 30 million kW. One might surmise that power requirements will continue to grow at an average rate of more than 6% per annum and require the construction of upwards of 50 million kW of new capacity by 1980.

The local or regional character of the power pattern and its early reputation as a stable investment has meant that Canada's electric power resources have, for the most part, been developed by Canadian capital. I would expect that most of the new money required by the established utilities will continue to be raised in Canada.

However, the size of proposed new hydro developments would appear to provide an opportunity for British investment in Canada; indeed, it has so far taken a prominent part.

Resources for the future

Although statistics pertaining to some of the lesser-known sites are frequently incomplete, Canada's presently measured water-power potential is in the vicinity of 34½ million kW. It is quite possible that the commercial water power potential will be rated at 70–80 million kW as compared with the present installed turbine capacity of 20 million kW. Regionally, Quebec and British Columbia have by far the largest undeveloped hydro resources, with Newfoundland and Manitoba following.

Some of Canada's main industrial centres will have to resort increasingly to thermal generation, because of full development of water resources. Ontario and the Maritimes in eastern Canada and Alberta and probably Saskatchewan in western Canada will be provinces consistently using thermal generation in the future. Diesel-electric generation has its place in the Canadian scene too, particularly in isolated communities. Within the last few years the gas turbine has also found application on the prairies, where natural gas is readily available; it has also been used in British Columbia for firming up hydro power during critical water years, for meeting peak loads, and for emergency stand-by.

Although nuclear research is taking close to 50 million dollars a year in Canada, it seems likely that nuclear power will first reach commercial proportions elsewhere. The exception is Ontario, where nuclear plants may be considered interchangeable with conventional thermal plants in the latter part of the present decade. Nuclear power is a possibility in the Maritimes and also in southern Manitoba.

In 1960 the proportion of thermal total-installed capacity was approximately 18%; by 1970 it is expected to be 26%; and by 1980 (by which time nuclear plants will be well into production), about 40%.

Some current proposals and problems

British Columbia would like to export power to the U.S. on long-term contracts at the end of which the power is recaptured, i.e. no power need be delivered thereafter. Along with Quebec it has by far the largest hydro potential in Canada but it has a small annual load growth and for economic development of its resources it needs a larger market for its power.

Within twenty-five years or so nuclear power located at load centres will probably be cheaper than energy from distant rivers like the Peace, so unless British Columbia's hydro potential is developed quickly it may not be developed at all.

Most of the long-distance transmission in Canada is of the order of 230kV, with some 360kV in operation. A 460kV line is planned for Ontario Hydro, and the Peace river proposal envisages transmission of close to 600 miles at 500–600kV.

Out of the present interest in extra-high-voltage long-distance transmission has developed an advocacy in some quarters for the construction of a power grid, east to west across Canada, a distance of some 3 000 miles.

The costs are formidable, especially when geographical aspects are examined, and it seems more likely that local networks will first evolve into well-rounded regionally interconnected systems and, later, that transfers between the regional systems will be undertaken on a scale large enough to justify transmission costs.

One aspect of hydro development characteristic of rivers along the Pacific coast is the problem of the commercial salmon fisheries. The Government line is that until more certain techniques are evolved for preserving the safety of the spawning fish on their journey upriver and the young fingerlings downstream, rivers with no salmon problem should be developed first.

British Electrical Manufacture in the National Economy

by STANLEY F. STEWARD, C.B.E., M.I.PROD.E.

When I was invited to give this paper it was suggested that as this year is the golden jubilee of the British Electrical and Allied Manufacturers' Association it would be appropriate to link the growth and future development of the electrical manufacturing industry with its trade association.

In 1902 the National Electrical Manufacturers' Association was formed and eight years later it widened its activities, changing its name to B.E.A.M.A. Its activities began to be of immediate benefit to the industry, embracing conditions of contract, the establishment of overseas committees, liaison with Government departments, and publicity. It provided backing in the fields of standardization, research, and technical education. The creation of a special economic department whose economic studies received wide attention was another aspect of its activities.

In the depression years of the early 'thirties the Association's services changed to meet the new conditions in the industry. By 1938, as production and employment increased, the British electrical manufacturing industry became the world's largest exporter of electrical goods.

During the war, the key position of the industry became strikingly clear and in the post-war period every order book for power plant was filled to capacity.

The post-war period is characterized on the one hand by fundamental changes in the commercial structure of the industry, which started with the nationalization of electricity supply and proceeded by way of the Monopolies legislation to the Restrictive Practices Court, and on the other hand by the speeding up of technological advances in electrical plant, nuclear power, and electronics which have radically changed the pattern of production in the industry.

Through these changing circumstances of half a century the basic services of the Association—as spokesman for the industry and forum for discussion, co-operation with Government departments, provision of information, and promotion of exports—have remained fundamentally the same, although their shape and emphasis may have altered to meet the developing needs of the times.

Electrical manufacture—a key industry

The industry now supplies about £1 600 million electrical and allied engineering products a year, of which nearly one-fifth is exported. Total employment is close on 800 000, representing a family population of nearly 2 million. More than one-third of the capital equipment of this country is supplied by it.

Electrical manufacture is the largest industrial employer of both scientists and technicians and the industry's increasing need of design and research staff is likely to make heavy demands on the available trained personnel.

With regard to investment, making allowance for ancillary activities (e.g. separate research laboratories), it is probable that a total investment of £400 million has been made over the ten years 1950–9, and two-thirds of this have been made during the last five years.

It is clear that earnings over this period have not risen to anything like the extent of the capital needed to generate them. As a consequence, the return on capital employed is lower than in many industries. Competitive trading conditions have cut profit margins and the maintaining of the industry's position against world competition has necessitated large sums being spent on research. It seems probable that the electrical industry as a whole is now spending £80–£90 million per annum on research.

Such factors have given a strong emphasis towards the grouping of firms through amalgamations or consortia and, perhaps unintentionally, the monopolies legislation has increased this tendency.

Electrical exports are of great importance in the United Kingdom national economy and the B.E.A.M.A. gives a high priority to activities which facilitate the export activities of its members. For several years, United Kingdom electrical exports, while steadily increasing, have secured a declining share of the expanding world market. The proportion of total exports to the Commonwealth has tended to fall slightly, but exports to the increasingly important western Europe markets have increased.

It is unfortunate that an expanding industry seems to invite frequent Government reviews and policy fluctuations. During 1960 the nuclear programme was halved, railway electrification was held up, and credit control changes played havoc with home and export markets for domestic appliances. The time has come to recognize that electrical manufacture is a growth industry of vital importance in the national economy and that its success can be seriously jeopardized by vacillations in the Government's capital investment and credit control policies.

A look at the future

The power plant programme assumed that there would be some decline in the 6·9% average rate of increase in demand which has occurred in recent years. I believe that a programme on this basis might leave too narrow a margin of capacity under severe weather conditions. Nothing could be more damaging to the cause of electrical development than any uncertainty about the continuity of supply. While the C.E.G.B.'s overriding consideration must be the maximum efficiency and economy in the operation of the national generating system, our ability to compete successfully abroad in this all-important field depends on the full and efficient use of our productive capacity.

Domestic electrical appliances have their individual sales tendencies in relation to market saturation. The milestone of equal deliveries of gas and electric cookers is near; but with attractive design features electric cooker deliveries should continue to increase. It is becoming widely realized that for short-period heating electric space-heating is unrivalled for cost, convenience, and cleanliness, while modern developments of floor heating and off-peak storage heating are bringing the complete electric heating of commercial and domestic premises right into the realm of practical and economic advantage.

Reciprocal trade between countries with high living standards seems likely to be an important factor in the future of the electric appliance business. The B.E.A.M.A. commissioned a special study of the Common Market countries and this has brought out the tremendous opportunities for British electrical exports to Europe during the next five years.

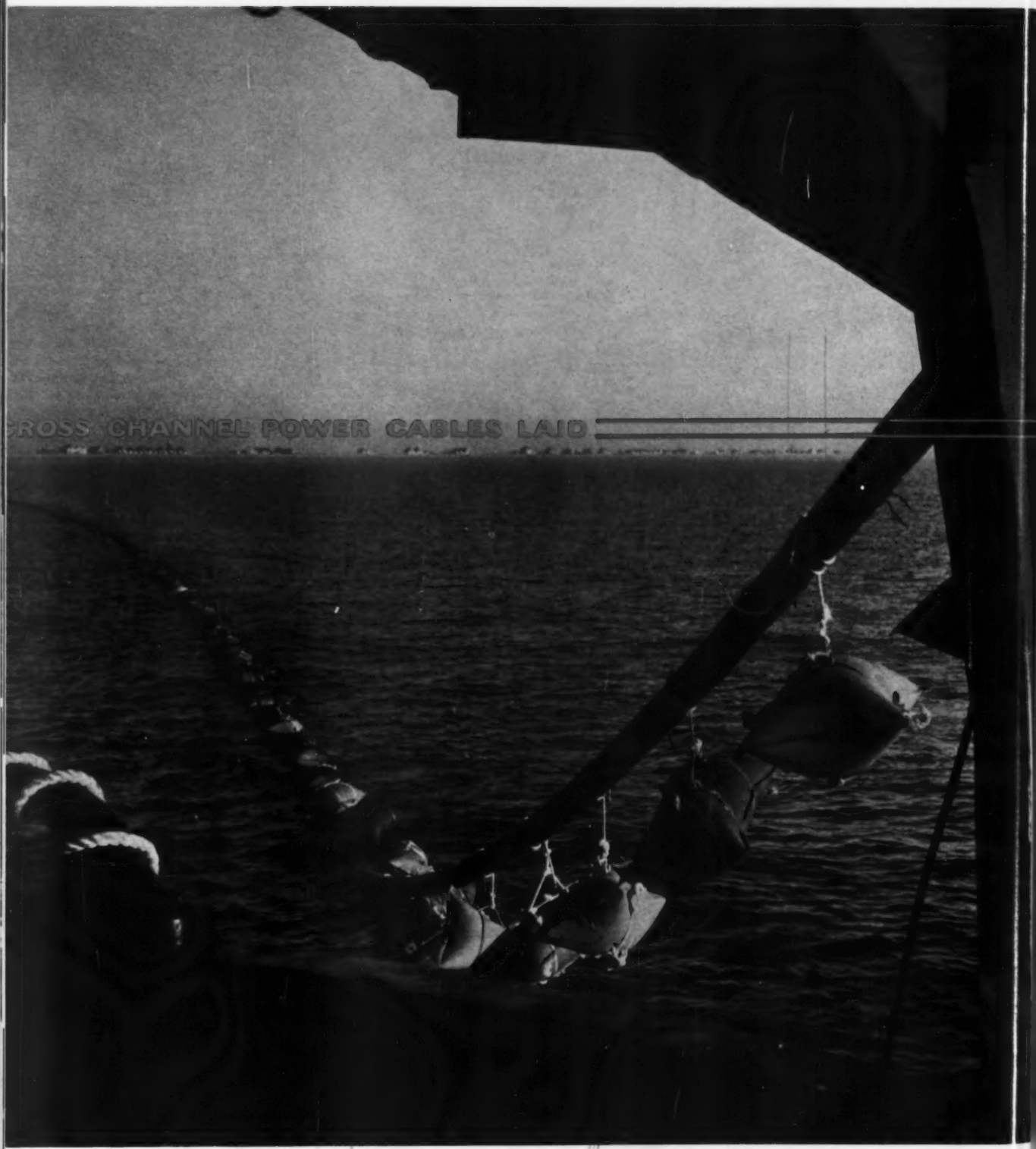
Finally, the services and facilities offered by the B.E.A.M.A. over the whole field of information seem likely to provide the basis of co-operation in the electrical manufacturing industry in the future and this will ensure that the industry retains its position as a leading exporter and that it will exert a dominating influence in productivity as well as raising the standard of living generally.

ONCE PROJECTS-NOW REALITIES

The P. & O.-Orient passenger liner *Canberra* is now on her maiden voyage to Australia.

This 45 000ton liner has A.E.I. main propulsion machinery of 85 000s.h.p.—by far the most powerful equipment of this type to have been manufactured in this country. A.E.I. has also supplied more than ninety miles of cables for the ship, four auxiliary geared turbo-alternator sets and four turbo-compressor sets.

The radio telescope in the second illustration is the new machine at Parkes, New South Wales, which will be in operation this autumn. As mentioned in the November 1960 issue of ELECTRICAL DISTRIBUTION, A.E.I. has supplied special cables for this radio telescope with an accompanying "anti-twist" mechanism. In front of the building the drums of A.E.I. cable can be seen. The servo control system and a "Clearcall" communication system are also of A.E.I. design and manufacture.


ROSS CHANNEL POWER CABLES LAID

Viewing the Decca Track Plotter on board the "Dame Caroline Haslett" are (*l. to r.*) Captain Richmond of the C.E.G.B., Commandant Demays of the "Ampère", and Mr Ramsay of the Decca Navigator Company.

ON FRIDAY MORNING, 9 June, a long line of gaily coloured floats lay on the sea between the coast of Dungeness and a vessel standing off-shore.

The vessel was the *Dame Caroline Haslett* and beneath the floats were suspended the two British cables which were to form half the power link between Britain and France.

Cable-laying operations had begun.

Inclement weather had put back the initial date proposed for laying the cables. On the French side of the Channel two cables manufactured in France, scheduled for laying earlier, were already on the ocean bed, marked by buoys in mid-Channel.

Previously, the C.E.G.B. collier *Dame Caroline Haslett* had spent four days at Manchester loading the B.I.C.C. manufactured length, followed by nearly three weeks at Woolwich. During these three weeks the huge mass of cable-laying and cable recovery gear was fitted topsides to convert her to cable-laying duties and the A.E.I. cable was coiled in her second large hold. Ancillary equipment was stowed in a smaller forward hold.

The *Dame Caroline Haslett* had made an uneventful passage to Dover and all had been ready for preliminary operations to begin at the end of May on the appropriate morning tide, when the weather had changed and operations were suspended. From the Lydd convertor station to the Dungeness link house, a distance of some 4½ miles, the land cables had been laid, using 0·6sq.in. conductor cables where ordinary soil was encountered and 0·925 sq.in. conductor cables in shingle areas. From the link house through the shingle to the shore, 0·925sq.in. conductor cables were already in position.

A caravan had been set up on the foreshore at Dungeness to establish radio contact with the *Dame Caroline* for the relaying of information. A trench had been bulldozed in the shale of Dungeness beach and the winch to be used for hauling the cables ashore was anchored at its farther end.

Operations had started at 3.30 a.m. on Friday, 9 June. The winch wire, already run out some distance seaward, had been picked up at its marker buoy by a fishing boat and brought out to where the *Dame Caroline Haslett* lay ready. Immediately, it had been taken on board and shackled to the end of the two cables, ready to pull out.

The cables, lashed together, were now ashore, fastened to sand anchors and suspended above the sea bed by floats. Sea conditions were moderate.

Four frogmen clad for skin-diving slipped overboard from one of the fishing vessels attending the cable-laying ship and, working together from the ship end, commenced to cut the lashings which held the cables to the floats.

At 10.55 a.m., when about one-third of the cable lengths between ship and shore lay on the sea bed, the *Dame Caroline Haslett* received the signal from Dungeness that all was ready to proceed. The vessel stood out to sea at a steady 3·6 knots on a course magnetic east for approximately three miles, paying out two lengths of cable simultaneously, side by side. She then altered course for the final twelve miles to a line which brought her to the arranged mid-Channel chart reference. This was a prearranged course, plotted on a Decca Survey Track Plotter, which the vessel followed closely by instruments during the operation. As soon as she was under way from Dungeness, two divers in conventional gear descended from an attendant vessel to check that the cables near the shore, released from their floats, lay close together—two thin parallel threads connecting ship to shore.

At 2.15 p.m. that afternoon the *Dame Caroline* sent the expected signal that the cables, with the temporary

terminating joints sealing their ends, had been laid to mid-Channel where, in fifteen fathoms of water, the British and French marker buoys swung on the waves to mark the spot. The *Dame Caroline* had overlapped the French marker buoys for a considerable distance before dropping her cable ends, in order to facilitate the task of the French cable vessel *Ampère*, from which the cables were to be raised and jointed later.

From the shore, the two British cables were then subjected to a test at 200kV d.c. negative for five minutes and found to be satisfactory.

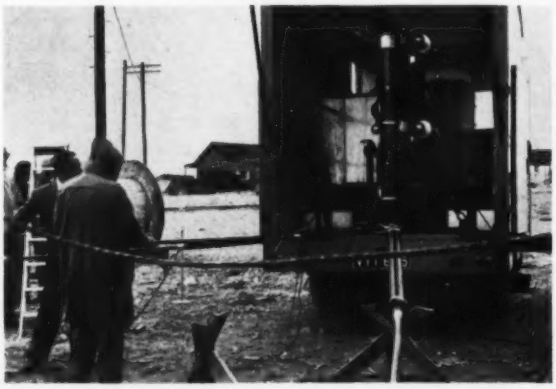
Jointing crews from the two manufacturing firms had been standing by and the next day, Saturday, they commenced jointing to link the land cables (0·925sq.in. conductors) and sea cables (0·525sq.in. conductors). Both joints were completed on Sunday morning, and later the cables were positioned so that the joints lay at low-water mark.

The following Tuesday satisfactory tests were carried out on the completed cables to mid-Channel from the Dungeness link house—a one-hour test at 200kV d.c. positive and a one-hour test at 200kV d.c. negative.

On Wednesday, 21 June, in fair weather, the French cable vessel, the *Ampère*, hove to in mid-Channel where she recovered the ends of the British and French cables and proceeded to joint. This task was finished next day and the completed cables were lowered to the sea bed. The cables, now solidly connected between France and England, were pressure tested at 200kV d.c. positive and negative for one hour.

Britain and France were connected by a submarine power cable link.

Work still remains to be done on various aspects of the project, as the total British effort includes the Canterbury–Lydd 275kV line and the new convertor substation at Lydd, but the important undersea cable link is laid, ready to play its part in the 160MW power interchange between this country and the Continent.



Cable-laying sequences.

Top: **the cables being laid over the stern skid of the "Dame Caroline Haslett", through the brake gear.**
Centre: **preparing to joint the sea cables to the larger shore cables on the beach at Dungeness.**
Bottom: **discharging cable after completion of the C.E.G.B. acceptance test on the A.E.I. cables from the link house to mid-Channel.**

E.C.A. Diamond Jubilee Conference 1961 – Torquay

A CIVIC WELCOME began the proceedings of the Electrical Contractors' Association's Diamond Jubilee Conference, held at Torquay in June. After the welcome by the Mayor, Councillor T. B. Revill, the president, Mr C. R. Waterhouse, thanked him and delivered his presidential address to the assembled delegates.

After congratulating the British Electrical and Allied Manufacturers' Association on the achievement of its Golden Jubilee, Mr Waterhouse proceeded to matters closely concerning the Association. Although a personal advocate of the system of voluntary membership, he wondered whether he was right and whether this old and traditional system was correct. There were those who freely take all the benefits which result from the Association's activities without accepting any of the responsibilities, financial or otherwise. Yet others became a member of their organization but failed to take any part in its proceedings. As a country, he said, we seem to be the victims of a wave of apathy which amounts to the complete disregard of personal responsibility.

Why our politicians had sought to destroy the existence of the Fair Trading Council seemed to him to be the negation of common sense and a refusal to recognize the eminent desirability, in the public interest, of a stable home trade.

On the subject of competitive tendering he would be the last to object to this fundamental principle, but he believed that in the national interest a determined effort should be made to avoid the vast wastage which at present existed in tendering for building projects.

Price cutting by electrical retailers was irresponsible. "I would say with great emphasis," he told his listeners, "that no retailer can sell electrical current-consuming devices at less than the manufacturer's list price and at the same time meet his responsibilities to the public and the industry by giving adequate technical service at the time of the sale and thereafter." He deplored organizations formed purely for the purpose of obtaining discounts on their requirements, particularly the facilities extended by so-called wholesalers through which this system of trading was conducted.

A situation for which a remedy should be sought was that relating to the various contractual conditions in existence: the electrical contractor had to spend a tremendous amount of time and effort in studying the conditions under which he was called upon to quote. These varied in respect of almost every inquiry he received.

The Mayor of Torquay greeting E.C.A. delegates.

Left to right: **Mr G. N. Walker, president-elect, Mr C. R. Waterhouse, J.P., president, Councillor T. B. Revill, Mayor, and Mr L. C. Penwill, C.B.E., director, E.C.A.**

Mr Waterhouse thanked the director, Mr Penwill, for his help during the president's year of office. He payed tribute to his wife for her understanding and concluded: "Whatever the sacrifices, the fatigue, and effort which presidential duties demand, they have provided for me in return pleasure and enrichment which I find quite impossible to describe."

The Conference programme which followed comprised a joint paper by three authors on the past, present, and future, under the chairmanship of Mr J. G. Briggs, who was co-ordinator for the session; a symposium on trading problems by a panel of representative electrical manufacturers; and a final paper on the better lighting of offices. These are summarized in the following pages.

The business proceedings were completed at a final session when Mr Waterhouse passed his badge of office to the new president, Mr G. N. Walker. To bring the 1961 Convention to a close, the president and Mrs Waterhouse gave the traditional reception.

Past, Present, and Future

The Past

by L. C. PENWILL, C.B.E., COMP.I.E.E., Director

After briefly reviewing the growth of the electrical contracting industry from pre-twentieth-century days, Mr Penwill's paper described the setting up of the National Electrical Contractors' Association in 1902 when the late W. R. Rawlings was elected president and the late Howard Marryat, who founded the *Electrical Contractor* in 1903, was elected honorary treasurer. In 1904 the Association was reconstituted as The Electrical Contractors' Association (Incorporated).

In 1918 a scheme was put forward by the I.E.E. for a National Electrical Proving House. This matter was also explored at very great length in 1934. All efforts to persuade the Government to afford protection to the life and property of the public failed completely, hence the voluntary British Electrical Approvals Board which is now in existence.

For the past seven years the Association has actively participated in the deliberations of the electrical contractors' International Association; unfortunately, its "international" coverage has been somewhat restricted: up to the present only seven associations in Europe are members and India has just joined the ranks.

The question of whether to enforce compulsory registration of contractors has had a varied history and eventually the National Inspection Council for Electrical Installation Contracting was inaugurated in 1956 as a system of voluntary registration. The whole industry will be aware of its coverage and influence.

The baleful effect of indiscriminate price-cutting in the early days of contracting eventually led to the first recorded meeting in 1905 between the National Electrical Contractors' Trading Association and the Cable Makers' Association at which was formulated the first of the agreements between the N.E.C.T.A. and the C.M.A. These various agreements existed for a great number of years until they were terminated in 1954 as a result of the intervention of the Monopolies Commission. The Fair Trading Council, which was dissolved as a result of the Restrictive Trade Practices Act, 1956, first issued its policy in 1933. "I cannot claim for it unqualified success," said Mr Penwill, "but I would go so far as to say that the industry generally, and electrical contractors and retailers in particular, would have been far worse off but for the existence of the policy."

The Present

by A. V. MILTON, ASSOC.I.E.E., Past President

Today we are approaching complete standardization of supply but we still have small pockets of non-standard systems originated sixty years or more ago.

With the heavier loads now being used in all types and sizes of buildings, it becomes increasingly difficult to serve consumer loads above 100kW from the medium-voltage network so that new and augmented demands above that capacity are usually supplied at high voltage, with transformer substations on consumers' premises. The relatively recent amendment of the Electricity Supply Regulations, permitting under defined conditions the use of protective multiple earthing on supply systems, has resulted in development of the system in many rural areas and is of great benefit to consumer and supply authority where there are difficulties of obtaining low-resistance earths owing to the high resistivity of the ground.

Most of the systems now in use were the same or similar in principle to those used sixty years ago, but mention must be made of the once-popular wood-case wiring which has gone out of use and the m.i.c.c. cable which is now extensively used.

In open spaces or large open buildings, considerable advantages and economies are possible using the grid suspension system with cables embodying a catenary wire and used in conjunction with joint boxes for the attachment of lighting fittings or for tappings for small power. The low cost of tough rubber and plastic sheathed wiring systems undoubtedly encourages greater domestic use of electricity.

Greater attention to the economic and scientific use of materials has produced equipment that, while well matched to its duty, has cleaner and simpler outlines than in the past.

The characteristic of simplicity and unobtrusiveness of present-day installations is a tribute to the art of the installation engineer who must employ a high standard of detail and precise planning in the designing of electrical installations.

The Future

by S. L. M. BARLOW, M.I.E.E., M.AMER.I.E.E.

In the contracting side of our activities the possibilities are almost limitless and as the size and complexity of installations increase, so will the volume of work and the degree of specialization. In my view the Area Boards will likewise tend to specialize and to keep more and more to their real business of distribution of electricity so that their contracting activities will progressively decrease. The private retailer will, however, have to meet strong opposition from this quarter, but I am confident that he will enjoy an increase in business at least equal to that of the Area Boards.

We do far too little to help in the technical training and encouragement of apprentices and young men entering our industry, perhaps because, as we are the training ground for the consulting electrical engineer, the workshop maintenance engineer, and others, we are inclined to feel that the cost is high in relation to the retained labour produced.

We have also to bear in mind that as the educational level of the country improves, as it surely will, there will be fewer people willing to undertake practical work and so we shall be forced towards more automation in industry, including our own. It is highly doubtful if we have studied carefully enough the possibilities of increased mechanization as an aid to installation contracting.

On the Continent the use of plastic conduits, which can be bent cold or by immersion in hot water, is daily gaining acceptance and their use should increase in this country.

General technical trends include those towards standardization; an increased number of socket outlets in every type of building; the eventual supply of electricity on a rating basis; an enormous increase in the intensity of illumination and the fitting of automatic control systems motivated by increasing and fading daylight; the introduction of an armoured flexible cable system with purpose-made fittings for use in wall cavities, building voids, and false ceilings; and the possible abandonment of the wasteful loop-in system and a reversion to jointed tree wiring using hand-operated crimping tools.

New president of the Electrical Contractors' Association. Mr G. N. Walker (*left*), the new president, is congratulated by the retiring president, Mr C. R. Waterhouse.

Symposium

Trading Problems and Scope for Co-operation

The co-ordinator for the symposium was Mr S. F. Steward, C.B.E., director, B.E.A.M.A., who introduced the members of the panel. They were Mr R. H. Phillips (G.E.C.), Mr C. H. Broughton Pipkin (B.I.C.C.), Mr C. J. W. Scott (Crompton Parkinson), and Mr R. W. S. Mackay (Midland Electric Manufacturing Co.).

Mr Steward opened the discussion by emphasizing that the electrical industry was essentially one, and that if all concerned were to reap the maximum benefits from its "inevitable expansion" all must co-operate to the greatest possible extent.

Mr Phillips, covering wiring accessories and equipment, spoke of the necessity for adequate wiring, the need for more two-way switching, and development of the field presented by commercial offices. More adequate wiring would benefit everyone, but "because everyone would benefit almost everyone leaves it to everyone else and not nearly enough is done about it".

Mr Broughton Pipkin said that, as the growing consumption of electricity showed, the market was there—it had to be exploited properly. Speculative builders, for instance, could be taught that an adequate installation would make their houses more attractive to the buyer. Contractors should spread the gospel of maximum use of electricity.

Speaking of lighting, Mr Scott mentioned that in this field an ideal basis for co-operation existed between the manufacturers of lamps and fittings and the contractors who installed them. It would be at least worth the effort, he thought, to experiment on the value of technical interchange at Association level.

It was necessary for the right materials and services to be available, and for commercial self-discipline to be exercised: the lesson of "beggar-my-neighbour" trading in North America was there for all to see.

Mr Mackay was concerned over the ease with which any individual "however scant his training" could set himself up as an electrical contractor—a situation which should be tackled in the interests of public safety. No other country was so lax in regard to the proper qualifications for electrical contracting as we were.

Now that the Fair Trading Council had disappeared, he suggested that a small select committee could be formed by the Association to discuss matters of common interest with the manufacturers, either individually or through the B.E.A.M.A.

Contractors should wherever possible use standard equipment and so simplify their own problems and those of the manufacturers.

Better Office Lighting

by W. J. JONES, M.SC., M.I.E.E., Director, British Lighting Council

Better office lighting gives a bigger return from investment in staff, space, and equipment, greater speed and accuracy, less fatigue, less absenteeism, a smaller turnover of staff, and a happier and more efficient organization.

The main problems are to have enough light at the place of work and generally throughout the office, and to have lighting free from objectionable shadows and reasonably free from glare.

The recently published *I.E.S. Code for Good Interior Lighting* gives significantly higher levels of illumination than previously accepted. Generally, for offices it is 30lm/ft² with a limiting glare index of 19; but for business-machine operation and drawing-board illumination it is 45lm/ft² (limiting glare indices 19 for the former and 16 for the latter). Thus exposed batten fittings have little place in any office installation.

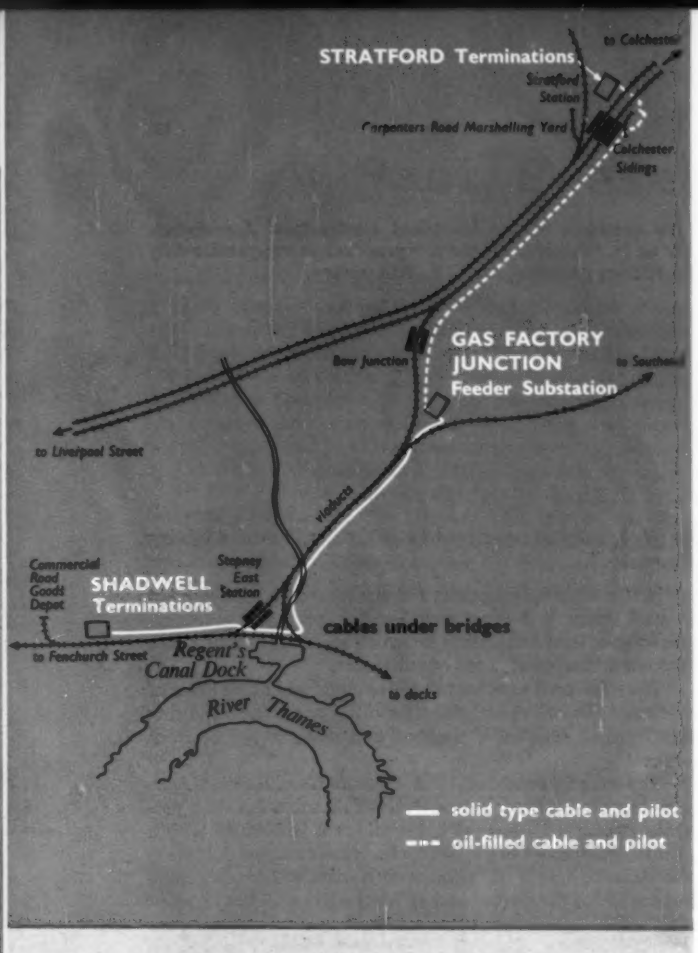
There is little technical difficulty in providing lighting up to I.E.S. standards for small offices up to 20ft square, but large offices require specialist attention if 30lm/ft² are to be provided with general comfort to the staff. Unless contractors have specialist staff engaged in illuminating engineering, I would urge them to take competent advice when planning for large areas.

Poor lighting in circulation areas increased the risk of accidents and badly lighted staircases are a particular hazard. The I.E.S. Code gives 7–10lm/ft² for such areas.

Daylight should be supplemented by artificial light, and due consideration should be given to that part of a room farthest from the windows. In some situations permanent supplementary artificial lighting may be necessary, and a paper by Hopkinson and Longmore, *Permanent Supplementary Artificial Lighting*, advocates such a system at the back of a room of about 50lm/ft². It may well alter the shape of buildings to come. In this connection it should be noted that built-in lighting is often visually disappointing at levels less than about 50lm/ft.²

In a recent experiment people with a free choice chose values of about 200lm/ft² average for typical office jobs such as typing and filing.

Contractors who wish to get a good share of business out of office lighting should first invest in a good light meter; they should sell the idea of good office lighting by and in their own premises, possess a copy of the new I.E.S. Code, and purchase a supply of the British Lighting Council's promotional leaflet *Seeing about your office*. They should participate in Office Lighting Week, 23–28 October, order a copy of the New B.L.C. book *Office Lighting* which will be available for early autumn, and be enthusiastic about lighting promotion.



EASTERN REGION FEEDER

A CONTRACT WHICH illustrates the supreme importance of close co-operation between contractors and the staff of British Railways during cabling for railway electrification work is being completed in east London for British Railways Eastern Region.

The work is concerned with the provision of a 33kV feeder from Shadwell to Stratford primarily to supply a new traction feeder station at Gas Factory Junction for the London–Tilbury–Southend line and also to provide an alternative feed to Stratford feeder station in connection with the new a.c. electrification of this section of the Eastern Region. At the Stratford end the cables were laid under and beside the busy Liverpool Street–East Anglian main line, while at Shadwell the engineers had to cope with the constant rail traffic on the Fenchurch Street–Southend lines.

Some of the difficulties presented to the A.E.I. Construction Division personnel on this contract, besides the heavy traffic conditions, were: the very limited space alongside the main running rails, resulting from a large proportion of the track in this area running over viaducts, leaving little trackside room for the men to work in safety; very poor access for road vehicles; and the existence of a large number of obstructions such as overhead conductor-supporting structures and signal gantries, which made it extremely difficult to lay cables in a straightforward manner from the railway wagons into the prepared route.

Many of the joints had to be made off under special track possession arrangements, as the protective tents and plant items used in the jointing work fouled the Ministry of Transport gauge clearance limits.

These formidable difficulties, while presenting their own particular problems, were largely overcome by the close co-operation of the railway staff with A.E.I. site engineers in planning the various track possessions required—a procedure which, allied to the associated problems of planning material deliveries to the site of operations for any particular day's work, called for the closest liaison between all concerned.

The route map shows how Gas Factory Junction substation is situated approximately midway between the Stratford and Shadwell terminating points of the cables installed. Along the northern half of the route, 3 600yd in length, were installed a 33kV 0·23sq.in. shaped aluminium conductor, 3-core corrugated aluminium sheathed oil-filled cable, and a 0·007sq.in. 7-core

Illustration on opposite page shows 33kV oil-filled cable being drawn off drum prior to pulling under the track at Stratford.

Top (*this page*): **the cable emerging from the undertrack ducts at Stratford.**

Below: **the situation at Regent's Canal Dock, Stepney, where the problem of limited space and an acute angle in the cable route was overcome by using asbestos pipes slung beneath the railway bridges.**

aluminium sheathed cable providing protection circuits and low-oil-pressure warning indication. Both cables have protective serving overall and the straight-through joints were suitably tape served and sheathed by hand to withstand a 10kV d.c. to earth serving test at the completion of installation.

The cables along nearly one-third of this section were laid in new reinforced concrete troughing in the track-side cess at surface level, but the remainder had to be accommodated on existing reinforced concrete posts, concrete, steel, and brick bridges, girders and platforms, and in ducts at undertrack crossings. The undertrack ducts were installed by the railway District Engineer's Department. The many different types of supporting structures kept A.E.I. site draughtsmen fully occupied for several months, designing fixings and obtaining the necessary approval for the variety of cable supports proposed.

For the Gas Factory Junction–Shadwell section, totalling a further 3 500yd, a solid type 33kV 0·15sq.in. copper conductor 3-core, mass impregnated and served feeder was laid, with a 0·007sq.in. 4-core pilot cable to provide protection circuits. A completely new cable route was installed by A.E.I. engineers, consisting of the normal surface level r.c. concrete troughing laid in the cess, and "hand-tailored" suitably approved methods of crossing bridges and viaducts by means of asbestos pipes supported by galvanized steel brackets.

One particularly awkward corner which had to be negotiated was present at Stepney, where the rail tracks border the Regent's Canal Dock. An acute angle in the cable route occurs here, with a lack of room for manœuvring which is exceptional even for this job. The problem of taking the cables from their positions beside one set of tracks on a small road bridge, under the tracks, round the sharp bend, and up a second bridge to run beside another track was solved by suspending asbestos pipes beneath and between the bridges and providing the necessary supporting steelwork. The situation called for a delicate and tricky piece of cable-laying which was, however, successfully accomplished during an arranged track possession.

Throughout the contract the usual principles of cable-laying alongside railways were adopted—that is, running out of cables was done from cable drums mounted on specially fitted railway wagons during night-time or weekend track possessions. Similar arrangements were made for the distribution of construction materials.

In spite of the major difficulties mentioned and the many minor problems which cropped up during construction and installation, the purposeful co-ordination of activities between the British Railways Eastern Region electrical engineers, civil engineers, and A.E.I. Construction Division enabled the work generally to reach completion in accordance with the initial programme.

New British Standards

B.S. 3346:1961—Armoured P.V.C. Insulated Cables

This is a new Standard dealing only with armoured cables, as apart from p.v.c. insulated cables and flexible cords for electric power and lighting which are dealt with by B.S. 2004:1961.

Reduced thicknesses of insulation are a feature of the new specification and two new voltage ratings have been added—660/1 100V and 1 900/3 300V. P.V.C. armoured cables have shaped conductors, except in the smallest sizes, and the Standard provides for either copper or aluminium conductors. Plain conductors have been standardized.

The usual electrical tests are included and appendices cover the installation of these cables and give appropriate values of armour resistance. *Price* 8*s.* 6*d.*

B.S. G.177—Nyvin type Electrical Cables for Aircraft

All British Standards relating to aircraft electrical equipment are now being brought together in one series, the "G" series, and E.24 has now been replaced by the new G.177.

The Standard provides only for cables suitable for aircraft use at stabilized conductor temperatures up to 105°C. These cables were introduced into E.24 by an amendment (PD 3360) in 1959, under the designation, "Type A". They are superior to Type B cables with a limiting temperature of 90°C, which were provided for in the first edition of the Standard, in having a better temperature performance and smaller diameters, in saving weight and space, and in being more flexible. They are distinguishable from Type B cables, which have black size-markings, by the use of red markings on copper cables and of yellow markings on aluminium cables.

Price 15*s.* 0*d.*

B.S. G.178—Crimped Joints (Non-insulated) for General-Purpose Electrical Cables for Aircraft

At the request of the aircraft industry, a British Standard has been published which provides details of the requirements of aircraft constructors and operators for crimping non-insulated connections for general-purpose electrical cables for aircraft. The Standard (G.178) deals with the completed joints and, in part, with tools and terminal ends which it is intended will be the subject of more detailed Standards in due course.

In view of the dependence of satisfactory crimping upon the maintenance and setting of tools, the Standard contains recommendations for tests to confirm their serviceability. *Price* 6*s.* 0*d.*

MODERN PAPER MAKING

A.E.I. cables serve new No. 7 machine at the Gravesend works of Imperial Paper Mills

ACCUSTOMED TO THE size of their giant charge, paper-makers and engineers of Imperial Paper Mills keep a watchful check on the complicated process of paper-making in constant operation on their new No. 7 "Walmsley" machine at Imperial Paper Mills' Bycliffe works, Gravesend.

Housed in a two-storey machine house some 150yd long, the installation is completely self-contained. The scale, to one unaccustomed to the paper-making process, is shattering. Machines such as this which, with their ancillary equipment, have a capital cost in the region of £4 250 000 produce newsprint from baled chemical and groundwood pulp, plus a proportion of broke (paper returned for repulping) and other additives, under rigorously controlled conditions monitored by automatic controls at all stages.

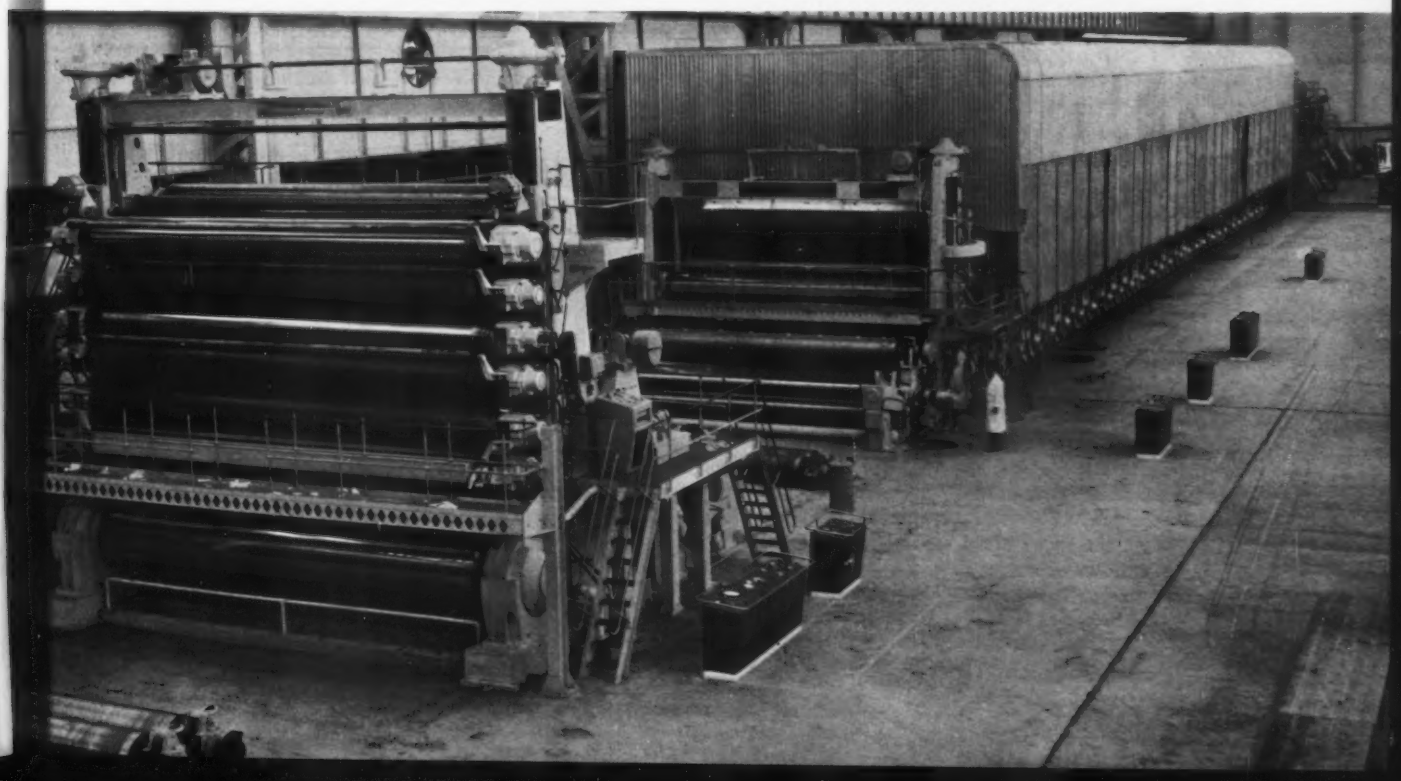
Plant

Imperial Paper Mills' No. 7 machine is some 350ft long and 23ft wide and of the vacuum transfer type. It can produce newsprint reels 238in. wide at a top speed of 2 000ft per minute (nearly 23m.p.h.).

The extensive plant required for its operation gives some idea of the work involved in the planning stage for which the engineers of Imperial Paper Mills are responsible when a new machine is scheduled for production.

A new 160 000lb per hour coal-fired water-tube boiler was the first consideration, to serve the new 8MW pass-out turbine generator set which fulfils all power and process steam requirements for the machine. Power at 6·6kV is fed from the alternator to the main h-t distribution board, more than 70ft long, situated in the turbine house. The board serves two 1 500h.p. Sulzer blower synchronous induction motors, a 2 550h.p. synchronous

The 350ft long Walmsley machine of Imperial Paper Mills which can produce newsprint 238in. wide at a top speed of 2 000ft per minute. Beside the machine are the remote-control consoles for the various sections.



induction motor for the paper-machine drive motor generator set, a 650h.p. super calender motor generator set driving motor, a 750kVA transformer for the power station and boiler house auxiliaries' circuits, and five 1 500kVA transformers transforming down to 415V for supplies to the various paper-making machine auxiliary plant via the main l-t distribution boards.

The l-t main auxiliaries are divided into three groups, serving the Preparation Plant, the Paper Machine Auxiliary Drives, and the Finishing Plant-Winder and Super Calender Auxiliaries.

The Preparation Plant auxiliaries are served by three transformer substations and l-t boards supplying drives for three hydrapulpers, five hydrafiners, four Jordan refiners, and feeder cables to six motor control centres controlling stock transfer pumps, backwater filters, agitators, and conveyors, etc. The Preparation Plant deals with the processing of the woodpulp and supplies the machine with paper stock at strictly controlled consistency and degree of beating.

A further transformer substation and l-t board provides power to drive four air-compressors and feeder cables to six motor control centres, controlling lubrication, pneumatic controls, vacuum and hydraulic systems, and machine auxiliary drives, such as distributor and rectifier rolls, conveyors, extraction fans, and water pumps.

The machine drive provides power at fifteen indrive points aggregating 3 750h.p. The motors are variable speed d.c. supplied from a Ward Leonard M.G. set driven by a power factor controlled synchronous induction motor. They are arranged in ten regulated sections, the regulation being electro-mechanical with overall electronic control of speed and voltage.

Finally, power to the dry end of the machine is taken via a single transformer substation and l-t board providing supplies to the winder motor generator set, and through sub-distribution boards to seven motor control centres which control auxiliary drives to this section and the winder, rewinder, and super calender.

There are thirteen remote-control consoles along the front side of the machine at convenient points of control for groups of motors and auxiliaries. Three consoles monitor the Preparation Plant, seven cover the machine, two control the super calender, and the final one the winder. On many of the consoles mimic diagrams provide easily read information on the process at every stage.

No less than 370 motors do duty on the machine—300 in the machine house and seventy in the power station and boiler house.

The contract for the extensive cabling for this huge installation was completed by engineers of the A.E.I. Construction Division, using paper-insulated and varnish cambric-insulated cables, m.i.c.c. types and p.v.c. insulated types. A great deal of work was involved, as 1 900 separate cables had to be connected to the equipment. By the time the installation was complete, more than forty-seven miles of cables were arranged in neat runs, radiating from the machine-room to all parts of the paper-making plant. In general, cables were run on racking, fabricated on site to Imperial Paper Mills engineers' requirements.

A brief description of the paper-making process, which may be followed by means of the diagrams, will explain some of the terms used in the foregoing description of the plant.

Paper-making

Although the quality of the paper is controlled throughout the whole paper-making process, the operation of the Preparation Plant, which prepares stock (pulp, additives, and water) for the machine, is largely responsible for the consistent quality of the final product.

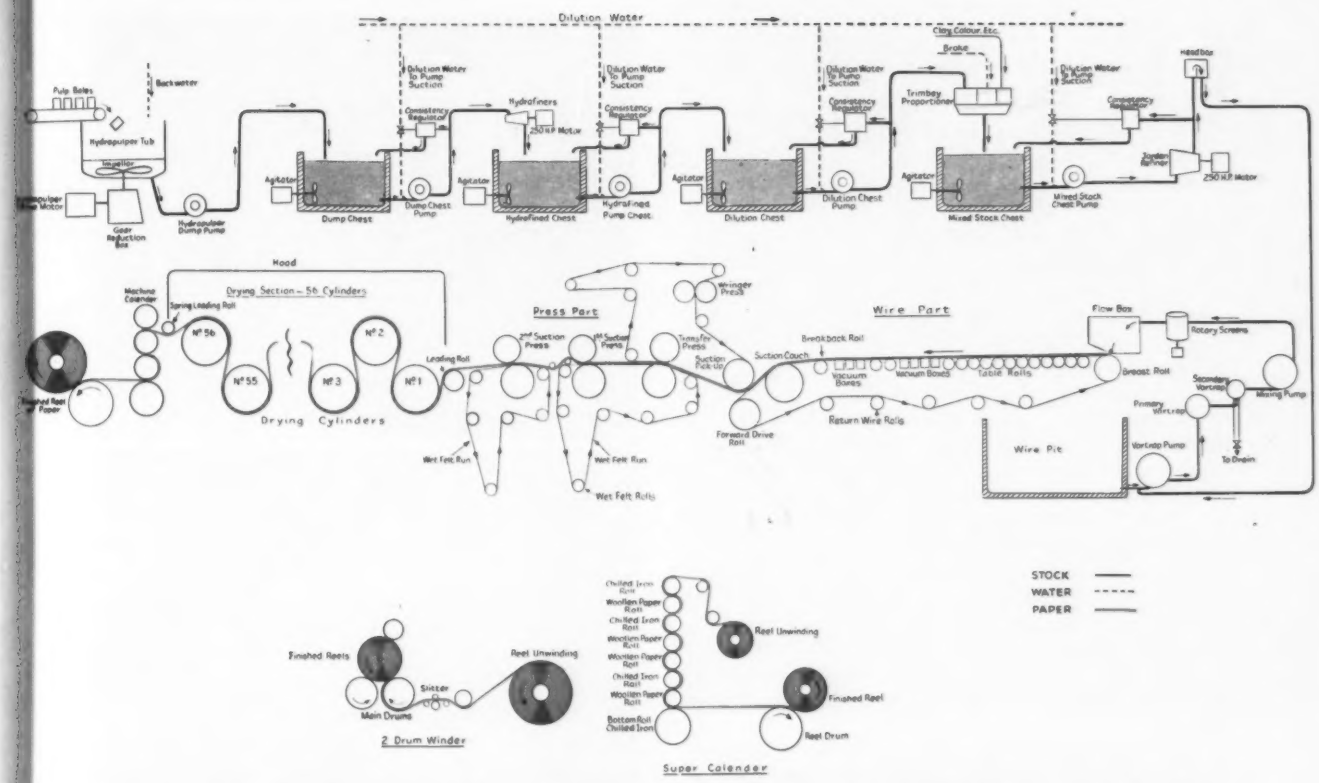
First, three hydrapulpers take groundwood bales and chemical pulp and reduce them with added water to a mixture containing approximately 5% fibre. This pulp mixture (stock) is then transferred into a dump chest by the hydrapulper dump pump. The stock passes through hydrafiners in which it is fibrilized. From the hydrafiners the stock is passed to a dilution chest via consistency regulators which dilute it to a 3% mixture. It is then pumped to a proportioner at which additives, such as dye etc., and repulped paper (broke), are included under controlled conditions. The resulting proportioned stock is passed into the mixed stock chest. From the mixed stock chest the stock is pumped via four Jordan refiners, which provide the final treatment to the fibres, to a constant head box from which the 3% stock flows, under gravity, to the suction side of a Vortraps pump.

At the Vortraps pump the 3% stock is mixed with water drawn from the wire pit of the paper machine and is further diluted to a very thin mix containing approximately 0·6% fibre and 99·4% water. The Vortraps pump passes the stock through the Vortraps where, by centrifugal action, any heavy particles of dirt are removed from the mixture and from there it passes into the suction side of the mixing pump which transfers the stock via rotary screens, which provide a final cleaning action, to the machine flow box.

At the flow box the stock is projected through a narrow rectangular orifice, the width of the machine, on to the paper-machine wire at which point it starts on its journey through the paper machine proper.

As the stock comes into contact with the paper-machine wire, which travels at approximately 1 900–2 000ft per minute, drainage of the water in the stock through the mesh of the wire takes place very rapidly. Drainage is encouraged by the use of stationary suction boxes over which the wire passes and by the use of a suction couch roll.

When the paper has passed the suction couch roll it is sufficiently compacted and dry (containing approximately 20% fibre at this stage) to be picked up from the wire on to a travelling woollen felt by the suction pick-up roll. The paper now adheres to the felt and passes between the nip of the transfer press, at which stage it is transferred from the underside of the pick-up felt to the top side of the first press felt.



A three-stage diagrammatic representation of the paper-making process. Starting top left: mixing of the stock proceeds until it flows under gravity to the Vortraps pumps and is pumped into the flow box of the paper-making machine. It then passes through the wire, press, and drying parts of the machine to emerge from the machine calender as paper. The paper is transferred to the super calender (*bottom*) to be finished, and is slit to printing width on the winder.

The sheet of paper then passes between the first and second suction presses, each of which comprises a bottom rubber-covered suction roll and a top roll made of granite on which a considerable pneumatically applied loading is exerted. On leaving the second suction press the sheet of paper is approximately 33 to 36% fibre. The sheet is fed into the drying section which comprises fifty-six steam-heated cylinders, around which the paper is fed and held in close contact by dry felts. In passing round the fifty-six drying cylinders the moisture in the paper is reduced from approximately 65% to approximately 6 to 8%, and the resulting vapour is drawn off through a hood which encloses the drying cylinders.

The dried paper is now fed through the machine calender which compacts the paper and then is passed on to the machine reel drum where it is wound up on reels approximately 6ft in diameter and weighing approximately 10 tons. This completes the paper-machine process.

At this stage the paper on the reel does not have a sufficiently high degree of gloss to meet the standards required by printers of newspapers and, therefore, the reel is passed through a super calender. Here it is fed through the nips of a stack of rolls in which chilled iron and woollen paper rolls alternate, pressed in contact with each other by pneumatic loading cylinders. The action of the super calender is to provide a reel of paper having the correct bulk and degree of finish to meet the standards for newsprint.

The super-calendered reel of paper is then transferred into the two-drum winder where the paper is wound up into finished reels of approximately 36in. diameter and of the required widths for accommodation into the printing presses.

During all the paper-machine and finishing operations, should any paper be spoilt or rejected for any reason, it is repulped by a broke hydrapulper and pumped back for use in the system in correct proportions determined at the stock proportioner.

It is interesting to note that when the stock is introduced at the flow box of the paper-making machine it comprises approximately 99·4% water which therefore means that huge amounts of water are necessary to the process, even though the water is subsequently removed. The plant therefore includes elaborate systems of fibre- and water-recovery and purifying plant in order to economize on the use of this most essential constituent of the paper-making process.

A.E.I.'s successful Moscow showing

A.E.I.'S SHARE IN the biggest British exhibition ever staged overseas was a 3 500sq.ft. stand at the British Trade Fair in Moscow's Sokolniki Park.

Among other things were shown a model of a 300MW turbine-generator set, a gas turbine station, a 275kV transformer, oil and air-blast circuit breakers, electric locomotives, the *Canberra*, and de Havilland's latest jet airliner (both A.E.I. equipped).

An A.E.I. mass spectrometer which had been sold to Russia was, with Russian permission, also on show. Topping the stand was an A.E.I. marine *Escort* radar.

The cable exhibit covered general cable types and cables manufactured for the shipbuilding, aircraft, mining, and railway industries. A special feature was made of the cross-Channel power cable.

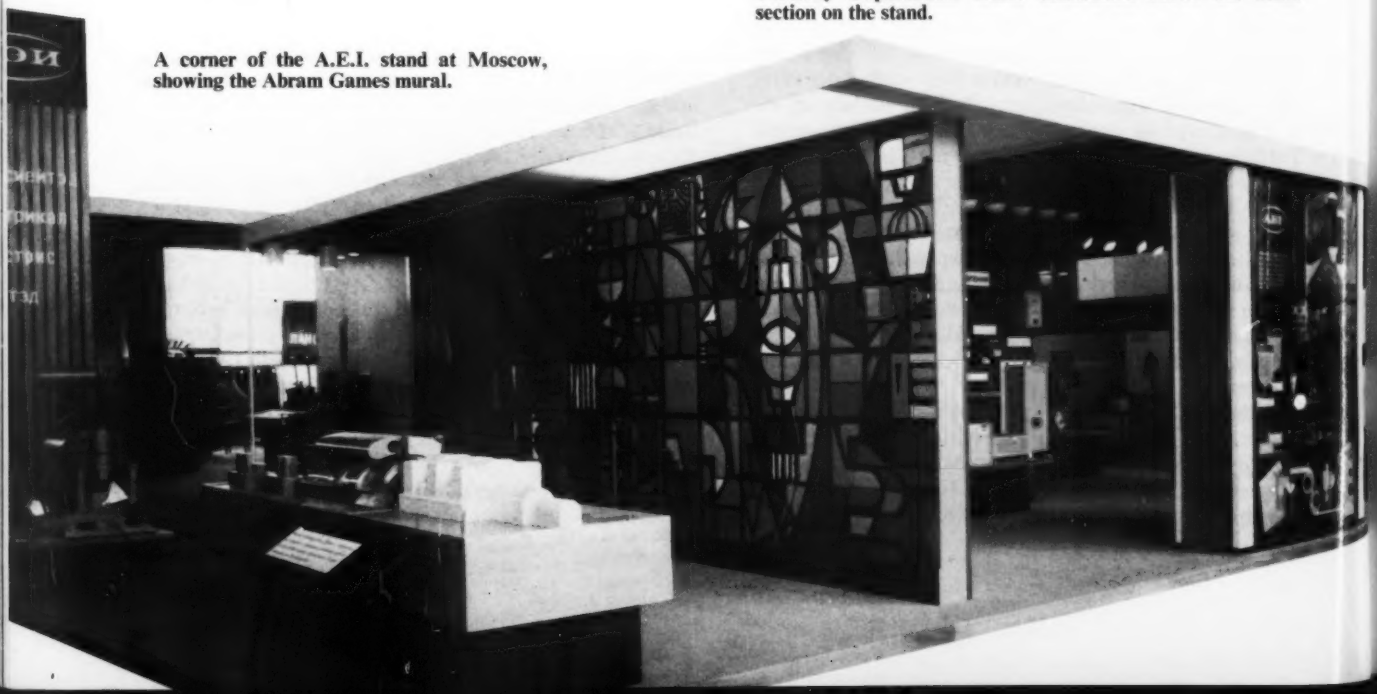
The friendliness and genuine interest of Russian visitors to the exhibition (limited to 75 000 a day) were unforgettable. A great many visitors showed almost inexhaustible interest in A.E.I. products. The cables on show provided a surprise—so great was the attention they drew that the Cable Division flew out extra staff to cope.

The large, coloured mural painted by Abram Games illustrating the diversity of equipment used in the generation, transmission, distribution, and use of electricity attracted much attention and favourable comment. It is seen in the accompanying illustration of the stand.

Four tons of A.E.I. literature printed in Russian, Hungarian, Polish, and Chinese were sent to the stand—but it went so quickly that eventually it had to be rationed out.

Top: **Mr Khrushchev visits the A.E.I. stand. From the left are: Mr Reginald Maudling, President of the Board of Trade, Mr G. Jolley, director, A.E.I. Export, Mr J. Howe who designed the A.E.I. stand, and Mr H. Lusty, media manager, A.E.I. Publicity Department. Other illustration shows the cable section on the stand.**

A corner of the A.E.I. stand at Moscow, showing the Abram Games mural.



PREPARING FOR THE CHANGEOVER IN LONDONDERRY

THE ARTICLE ON Coolkeeragh oil-fired generating station, in the July 1960 issue of ELECTRICAL DISTRIBUTION, mentioned that the generating station in Londonderry City was to be closed down, future power for the area being obtained from nearby Coolkeeragh.

The A.E.I. Construction (Cables and Lines) Division have now completed for the Londonderry Corporation Electricity Department the oil-filled cable installation required for the changeover. In doing so they excavated trenches by the historic walls of Derry which have played so large a part in the city's history—the most famous siege probably being that of 1688–9 when, during the occupation by James' II regiments, the citizens tricked the military while the troops were outside the walls and declared for William III; they held out for 105 days under such privation that rats became worth a shilling each!

Historic precincts apart, the contract was a fairly straightforward job. The cables installed form a bulk supply intake from the 33kV double-circuit overhead line which connects Coolkeeragh to Londonderry and serve as an interconnection between the system of the Londonderry Corporation and that of the Electricity Board for Northern Ireland.

Along a one-mile route length, a double-circuit of 0·3sq.in. 33kV 3-core oil-filled feeders, sheathed with lead alloy, tinned bronze reinforced, single wire armoured and served with waterproof finish, was laid between the switching station in Maureen Avenue and the Corporation's power station at Strand Road.

At each end of the route trifurcating oil stop joints were installed and the connections between the stop joints and switchgear were made with 0·34sq.in. single-core 33kV solid type cables. For oil engineering reasons the route is divided into two hydraulic sections by oil stop joints, one section being fed by tanks at Londonderry power station and the other by tanks mounted in the Corporation's Society Street substation about halfway along the route. Straight-through joints were installed to connect intermediate cable lengths.

Cable-laying in Londonderry. This illustration shows part of the historic walls of Derry and Butcher Gate. The monument in the background is to Bishop Walker, Bishop of Derry during the siege of 1688–9, which is mentioned on this page.

At the power station a low-oil-pressure/open-circuit alarm cabinet is installed; the low-pressure-oil alarm is operated by electric contact pressure gauges fitted at the oil pressure tank positions.

Alongside the oil-filled cables, two twin-core 0·0045sq.in. PILCSWA and S cables for system protection were laid, together with a 4-core 1/0·044 PILCSTA and S cable for the oil supervisory gear circuits and telephone communication between substations.

The narrowness of some of the Londonderry streets resulted in traffic difficulties while trenches were opened for the cable pulling and installation. In some instances it was necessary to close streets to vehicular traffic, and in others a one-way traffic system was maintained. Here the local Royal Ulster Constabulary earned the thanks of the engineers on the job by their helpful co-operation.

Mechanical pumps were often in operation to prevent flooding of trenches. The city of Londonderry is situated on the banks of the river Foyle, and in the low-lying sections of the route high tides threatened to flood the excavations and joint bays. The pumps kept on top of the flow, however, and the work was completed successfully.

PROBLEM CIRCLE

March Overseas Competition

If anything, Problem Circle appears to be even more popular overseas than it is in the United Kingdom.

Alternative solutions came up regarding the circle problem (Problem No. 3), some based on using semi-circles of the same radius as the smaller circle to divide the crescent of the larger circle into three. Also by using radii of $\sqrt{2}$ and $\sqrt{3}$ of the smaller circle (these can be found by construction methods), the large crescent can be divided into three crescents of equal area.

Overseas prizewinners of £1 10s. are:

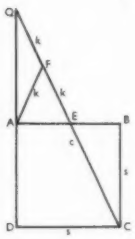
Problem No. 3—Mr D. R. Carter, 102 Montrose Maisonettes, 439 Alfred Street, North Sydney, N.S.W., Australia, who gave a very neat construction as a solution.

Problem No. 4—Mr K. A. Stone, The Jamaica Telephone Co. Ltd, P.O. Box 21, Kingston 5, Jamaica.

May Problems

Whilst **Problem No. 5** was shortly stated, the solution in our hands was quite lengthy. Most people chose the obvious way, dropping a perpendicular from the point F to AE=FG, working on similar triangles FEG, EBC.

The neatest solution, however, came from Mr W. Bacon of Anglesey. He made the construction shown and proceeded: as △s QDC, BCE are similar



$$\frac{QD}{c+k}=\frac{s}{c-k} \quad \ldots(1)$$

but $QD^2=(c+k)^2-s^2$ . . (2)

substituting 2 in 1: $\frac{(c+k)^2-s^2}{(c+k)^2}=\frac{s^2}{(c-k)^2}$

$$(c-k)^2=s^2\left[1+\frac{(c+k)^2}{(c-k)^2}\right]$$

i.e. $(c^2-k^2)^2=2s^2(c^2+k^2)$

This gives a quadratic in k^2 and, solving, we obtain

$$k=[c^2+s^2-s\sqrt{(s^2+4c^2)}]^{\frac{1}{2}}$$

The prize for this problem goes to **Mr J. D. Illingworth, 4 West Retford Hall, Retford, Nottinghamshire.**

Other neat solutions came from Messrs **C. F. Mitchell** of Bristol and **A. A. Neave** of Hull.

In **Problem No. 6,** the counter problem, we stated that "each series uses all . . . counters". Thus it was required to find a triangular number which was capable of being divided by six smaller triangular numbers. By empirical methods it is easy to find the first four such numbers (of which two were given in setting out the problem)—3, 6, 10, and 15. The next triangular number is 21 and here it is time to start examining lowest common multiples while listing further triangular numbers on the way. Thus we arrive at 210, itself a triangular number, divisible by all the foregoing numbers and by 105.

About half our friends jumped on 45 as an additional number and arrived at a solution of 630.

The first correct solution opened was that of **Mr W. Bacon, 52 Maes Hyfryd, Beaumaris, Anglesey,** whose solution to the previous problem has been quoted. Congratulations are due to Mr Bacon on getting both problems right.

July Problems

Problem No. 7

Another word sum. These are very popular and this one, submitted by a reader, is reputed to be a comparatively "tough nut".

	5
	20
	821
	3 706
	74 560
	266 749
	8 507 098
	74 075 698
	245 126 543
	906 512 690
	1 234 567 890

Problem No. 8

The grocer's unbalanced scales: a grocer has a pair of scales which are unbalanced. It is necessary to put exactly 1 lb more in pan B than in pan A to achieve balance. He knows this and uses the scale to weigh whole numbers of pounds only, making the necessary corrections in so doing. What is the maximum weight N (whole number) which he can weigh with five weights, and what are these weights which will allow him to weigh every whole number from 1 to N lb? Weights and objects weighed may be placed in either pan in any arrangement which will give correct balance.

Solutions to Problem Circle

Solutions to the Problems 7 and 8 should be sent to the Editor, ELECTRICAL DISTRIBUTION, Crown House, Aldwych, London, W.C.2. Envelopes should be marked "Problem Circle". *Closing Dates:* 18 August 1961 for competitors resident in Great Britain, Northern Ireland, and Eire. For overseas competitors the *mailing date* specified is 20 September.